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मानक

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IS 14603 (1998): Potato grader - Test code [FAD 20:
Agriculture and Food Processing Equipments]



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भारतीय मानक
आलू ग्रेडर — परीक्षण संहिता

Indian Standard
POTATO GRADER — TEST CODE

ICS 67.080.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Agricultural Produce Processing and Milling Machinery Sectional Committee had been approved by the Food and Agriculture Division Council.

Potato is an important food and vegetable crop, which is grown in India. One of the post-harvest operations for which potato growers and cold storage owners are presently facing hardships is the separation of potatoes into different size-grades. This is known as 'grading'. Grading helps the farmers in getting higher profit for their produce when sold in the market. Grading is also a requirement for seed purposes in accordance with the specifications laid down by the National Seeds Corporation and other Seed Agencies.

Potato graders are used for separation of potatoes into different size grades. Different types of potato graders have been developed and are being manufactured in the country. However, there was no test code to evaluate the performance of these machines. Therefore a need was felt to formulate this standard in order to have a uniform test procedure for potato graders.

In the preparation of this standard, assistance has been derived from the Punjab Agricultural University, Ludhiana.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

POTATO GRADER — TEST CODE

1 SCOPE

This standard prescribes the method for testing of hand and power operated potato graders.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Potato Index (*I*)

It is defined as follows:

$$I = \frac{L^2}{WT} \times 100$$

where

L = greatest length, mm;

W = greatest width, mm; and

T = greatest thickness, mm.

The dimensions *L*, *W* and *T* are respective averages from corresponding measurements of at least 50 tubers.

Depending upon the values of *I* the tuber shape can be defined as follows:

Round — From 100 up to and including 160

Oval — Above 160 up to and including 240

Long — Above 240 up to and including 340

Very long — Above 340

2.2 Square Measure

Pass at least 50 potatoes through a set of 7 square mesh sieves. The mesh width ranges from 25 to 55 mm in 5 mm steps. The square measure is indicated by stating the minimum size sieve through which none of the sample will pass and the maximum size through which whole of the sample will pass. It is expressed as mm/mm; for example 35 mm/50 mm.

2.3 Bulk Density

Mass per unit volume of potato tubers expressed in kg/m³.

2.4 Size Range

It is calculated on the basis of tuber width by the following expression:

$$\text{Size range} = W \pm SD \times W$$

where

SD = Standard deviation, and

W = Mean tuber width.

2.5 Grading Efficiency

It is the percent number of potato tubers conforming to a desired grade separated by a grader to the total number of tubers fed into the machine in a given lot. It can also be specified on the basis of the mass of desired grade tuber separated to the total mass of tubers in a given lot. It can be obtained by subtracting the grading error (see 2.9) from 100 when expressed in percentage.

2.6 Skinning Damage

It is defined as the percent damage caused to the potato tubers by the action of a grader on the basis of the percent skin of the potato tubers removed.

2.7 Cutting Damage

It is defined as the percent damage caused to the tubers due to the cut injuries resulting from the action of the grader.

2.8 Bruising Damage

It is defined as the percent damage caused to the potato tubers as a result of the bruising sustained to the tubers due to the operation of the grader. Bruising, essentially, implies the damage or rupture of the tissues of potato tubers without breaking of the skin. A bruised tuber develops a dark spot at the place of bruising after a few days.

2.9 Grading Error

Grading error is calculated on the basis of tuber numbers or tuber mass. It is calculated as indicated under 9.1.6.

3 SELECTION AND PREPARATION OF GRADER FOR TEST

3.1 Selection

For the commercial test, the grader shall be selected at random from the production line as directed by the Test Station. The Grader shall be complete with all accessories and in a condition generally offered for sale. The grader shall be new and shall not be given any special treatment or preparation for the test. The manufacturer can submit his machine for confidential

testing, if so desired. The nature of test required by the manufacturer shall be stated.

3.1.1 The manufacturer shall give a specifications sheet for the grader comprising all items listed in the specimen format given in Annex A and any further data required to carry out the tests.

3.2 Preparation of Grader for Test

3.2.1 *Running-in*

The grader shall be run-in before the test, under the supervision of the manufacturer. It shall be checked for its completeness. Particular attention shall be paid to the power transmission system and other moving parts, bearings, functioning of the grading, units/members, tightness of various fasteners namely, nuts, bolts, keys etc. The test report shall mention the place and duration of the running-in.

3.2.2 *Preliminary Adjustments*

The manufacturer may make necessary adjustments during the running-in period. Once the grader is prepared for the test, the adjustments shall not be changed during the test. In case, it becomes necessary to change the settings, alterations made shall be reported.

4 INSTRUMENTATION

The accuracy of measuring instruments shall have maximum allowable errors as follows:

- | | |
|--------------------------------|---------------|
| a) Rotational speed, rev/min | ± 0.5 percent |
| b) Time, s | ± 0.2 |
| c) Length, m or mm | ± 0.5 percent |
| d) Force, N | ± 1.0 percent |
| e) Mass, kg | ± 0.5 percent |
| f) Atmospheric pressure, kPa | ± 0.2 |
| g) Atmospheric temperature, °C | ± 0.5 |

5 CHECKING OF SPECIFICATIONS

The specifications supplied by the manufacturer shall be checked and reported in the format given in Annex A.

6 CHECKING OF MATERIAL

The material of construction of various components of the grader shall be reported in the format given in Annex B.

7 VISUAL OBSERVATION AND ADJUSTMENTS

7.1 The grader shall be examined visually and following observations shall be reported:

- a) Adequacy of marking of feed trough and outlets;

- b) Adequacy of marking of direction of rotation of main drive shaft;
- c) Adequacy of protection of bearings against the ingress of dust;
- d) Adequacy of safety arrangement, especially at moving points and at feed trough;
- e) Provision for lubrication of moving parts;
- f) Provision for belt tightening;
- g) Provision for transportation;
- h) Provision for changing of components requiring replacement;
- j) Provision for replacement and cleaning of grading spools/sieve/conveyor;
- k) Provision for anti-corrosive coatings;
- m) Welding of seams;
- n) Tightness of bolts, nuts and other fasteners; and
- p) Other observations.

7.2 The grader shall be examined for following provisions for adjustments:

- a) Feed rate,
- b) Speed,
- c) Pitch of sizing rollers/sieves,
- d) Grade sizes, and
- e) Slope of collecting platform/grading outlets.

8 TEST AT NO-LOAD

8.1 *Installation for Testing*

Install the grader on a level, preferably, hard surface and set the slope of the sizing bed or conveyor(s) in accordance with the manufacturer's recommendations. As far as possible, the test shall be conducted under still-air condition. Attach the grader with a suitable prime over, preferably an electric motor fitted with energy meter or transmission dynamometer for measuring the power input. The power delivered to the grader may be supplied in the following ways:

- a) Direct coupling of the primemover with the main driving shaft; and
- b) Connecting the primemover with the help of flat or V-belt and pulleys with main driving shaft of the grader.

In case of (a) the power delivered to the grader will be the power output of the primemover; whereas in case

of (b) the allowances for flat belt and V-belt drive losses may be taken as 6 and 3 percent respectively.

8.2 Energy Consumption

8.2.1 Set the energy meter by running the grader for 10 minutes and take the initial readings of the energy meter. Measure the energy consumption at no load for one hour.

8.3 Record the data as well as visual observations during and after the test in the format given in Annex C.

9 TEST AT LOAD

9.1 Short-Run Test

9.1.1 Install the grader as specified in 8.1 if no-load test was conducted at different place.

9.1.2 Operation and Collection of Data

Take sufficient quantity potatoes of each variety for conducting the short duration test. Operate the grader at the specified speed of the grading unit for one hour at the maximum input capacity. During the one hour run period collect the following samples and data.

- a) Take three sets of samples at an interval of about 20 minutes including the time for sample collection from the different outlets of the grader.
- b) Record the speed of the different shafts by revolution counter or a hand tachometer.
- c) In case of electric prime-mover, the readings of energy meter or dynamometer shall be taken at an interval of one hour.

At the end of one hour operation, run the grader idle for sometime, so that the material earlier fed into the grader comes out. Weigh the graded material collected from different outlets. If an engine has been used as prime-mover, record the fuel consumption during the operation period.

9.1.3 Repeat the test given in 9.1.2 for minimum three times at different feed rates covering the rated input capacity and approximately 50 percent of the maximum input capacity at specified speed; speed 15 percent higher than specified speed, and speed 15 percent lower than the specified speed.

9.1.4 Record the data as well as visual observations in the data sheet as given in Annex D.

9.1.5 Analysis of the Samples

Analyze the samples obtained at different outlets of the grader for different feed rates for the following:

- a) For cut tubers, by number and by mass, for each outlet;

b) Skinned tubers, by number and by mass, for each outlet; and

c) Bruised tubers, by number and by mass, for each outlet.

The average for three sets obtained at different feed rates shall be reported.

9.1.5.1 Record the data in data sheet as given in Annex E.

9.1.6 Calculation

9.1.6.1 Grading error

It shall be calculated on the basis of the tuber numbers or tuber mass. The following formulae shall be used for the calculations:

On the basis of tuber mass:

$$\text{a) Percent grading error for Grade 1 (E}_1\text{)} = \frac{(M - M_1)}{M} \times 100$$

$$\text{b) Percent grading error for Grade 2 (E}_2\text{)} = \frac{(M - M_1) - M_2}{(M - M_1)} \times 100$$

$$\text{c) Percent grading error for Grade 3 (E}_3\text{)} = \frac{(M - M_1 - M_2) - M_3}{(M - M_1 - M_2)} \times 100$$

Hence overall grading error for the Grader 'E' = $(E_1 + E_2 + E_3)/3$

where

M = Total mass of tubers, kg;

M_1 = Mass of tubers for Grade 1;

M_2 = Mass of tubers for Grade 2; and

M_3 = Mass of tubers for Grade 3.

Similarly, overall grading error for the grader shall be calculated on the basis of numbers of tubers collected in each grade.

9.1.6.2 Skinning damage

It shall be calculated as follows:

$$D_s = \frac{M_s}{M} \times 100$$

or

$$D_s = \frac{N_s}{N} \times 100$$

where

D_s = Skin damage, percent;

M_s = Mass of potatoes with damaged skin, kg;

M = Total mass of the tubers in a sample, kg;

N_s = Number of tubers with damaged skin; and

N = Total number of tubers in a sample.

9.1.6.3 Cutting damage

It shall be calculated as follows:

$$D_c = \frac{M_c}{M} \times 100$$

or

$$D_c = \frac{N_c}{N} \times 100$$

where

D_c = Cutting damage, percent;

M_c = Mass of cut tubers in a sample, kg;

M = Total mass of tubers in a sample, kg;

N_c = Number of cut tubers in a sample, kg; and

N = Total number of tubers in a sample, kg.

9.1.6.4 Bruising damage

It shall be calculated as follows:

$$D_b = \frac{M_b}{M} \times 100$$

or

$$D_b = \frac{N_b}{N} \times 100$$

where

D_b = Bruising damage, percent;

M_b = Mass of bruised tubers in a sample, kg;

M = Total mass of tubers in a sample, kg;

N_b = Number of bruised tubers in a sample, kg;
and

N = Total number of tubers in a sample, kg.

9.1.7 Determination of Energy Consumption

9.1.7.1 In case of energy meter fitted prime mover, the difference between two consecutive readings shall give the energy consumption for 60 minutes. Calculate the energy consumption for one hour giving due allowances to the type of drive. The allowances for flat belt and V-belt drive losses shall be taken as 6 and 3 percent respectively.

9.1.7.2 In case of dynamometer fitted prime mover the average reading taken shall give the average torque. Calculate the power requirement by the following formula:

$$\text{Power (kW)} = \frac{\text{Torque (kg.m)} \times \text{Speed (rev/min)}}{973.363}$$

9.1.7.3 Record the data in data sheet as given in Annex F.

9.1.8 Determination of Rated Capacity

Select the feed rate at which the grading errors are within ± 5 percent. Capacity in terms of energy consume shall be calculated by dividing the capacity by power consumed.

9.1.8.1 Record the data in data sheet as given in Annex F.

9.1.9 Determination of Output Capacity

Take the mass of graded potatoes received at different outlets and record the data in the data sheet given in Annex F.

9.2 Long Run Test

9.2.1 Operate the grader for at least 10 hours at load which should be covered by continuous run of at least 5 hours. Record the major break-downs/defects developed and repairs made in data sheet as given in Annex G.

10 SUMMARY

10.1 For the guidance of the users, compile a summary report in data sheet as given in Annex H.

ANNEX A
(Clauses 3.1.1 and 5.1)
SPECIFICATIONS SHEET

A-1 GENERAL

- a) Make
- b) Model
- c) Type
- d) Year of manufacture

A-2 POWER UNIT

- a) Provision
- b) Type of primemover recommended
- c) Rated power, kW
- d) Type of drive

A-3 MAIN DRIVE

- a) Type
- b) Size of belt or chain
- c) Size of pulley or size of sprocket
- d) Diameter of main shaft

A-4 FEEDING SYSTEM

- a) Method of feeding
- b) Height of feeding-trough, if any
- c) Type of feeding conveyor, if any
- d) Width of feeding conveyor, if any
- e) Conveying distance : Horizontal
Vertical
- f) Feed-conveyor drive

A-5 GRADING SYSTEM

- a) Type
- b) Number of spools/sieves/grading conveyors
- c) Pitch between spools or size of holes in the grading sieves or grading conveyors
Minimum (mm) _____
Maximum (mm) _____
- d) Width of spools or grading sieves/conveyors (mm)
- e) Drive

A-6 COLLECTING PLATFORM/DELIVERY CHUTES

- a) Length and breadth (mm × mm)
- b) Slope (deg)
- c) Number of dividers provided
- d) Number of grading outlets

A-7 BAGGING SYSTEM

- a) Bag fixing arrangement
- b) Height of holding clamps/hooks

A-8 TRANSPORT WHEELS

- a) Number and size of wheels
- b) Type of wheel-bearings
- c) Type of towing arrangement, if any

A-9 OVERALL DIMENSIONS

- a) Length with feed conveyor (mm)
- b) Length without feed conveyor (mm)
- c) Width (mm)
- d) Height with feed conveyor (mm)
- e) Height without conveyor (mm)

A-10 Number of labourers required to operate the machine

A-11 Total weight (kg)

A-12 Input capacity (kg/h)

ANNEX B

(Clause 6.1)

DATA SHEET FOR MATERIAL OF CONSTRUCTION**B-1 DATE OF TEST****B-2 MATERIAL OF CONSTRUCTION**

<i>Sl No.</i>	<i>Component</i>	<i>Material</i>	<i>Size</i>
i)	Frame		
ii)	Feed conveyor(s)		
iii)	Grading conveyors/sieve(s)		
iv)	Shafts		
v)	Pulleys/chains		
vi)	Transport wheels		
vii)	Platform		
viii)	Outlet		
ix)	Transport wheels		
x)	Others		

ANNEX C

(Clause 8.3)

DATA SHEET FOR TEST AT NO-LOAD**C-1 ENERGY CONSUMPTION**

- a) Source of power
- b) Type of drive
- c) Total time of run
- d) Average energy consumption for one hour
- e) Speed of feed conveyor
- f) Speed of grading conveyor(s)/sieves

C-2 VISUAL OBSERVATIONS

- a) Presence of any marked vibrations during operation
- b) Presence of undue knocking or rattling sound
- c) Frequent slippage of belts
- d) Smooth running of shafts in their respective bearings
- e) Any unusual play or slackness in any component
- f) Any marked rise in temperature of bearings
- g) Other observations

ANNEX D

(Clause 9.1.4)

DATA SHEET FOR TEST AT LOAD

- a) Source of power
- b) Power rating
- c) Type of drive
- d) Variety of potato
- e) Potato index
- f) Size of different grades of potatoes
- g) Speed of feed conveyors
- h) Speed of grading conveyors/sieves
- j) Slope of collecting platform
- k) Test data:

<i>Sl No.</i>	<i>Date</i>	<i>Starting Time</i>	<i>Stopping Time</i>	<i>Duration of Operation</i>	<i>Speed (rev/min)</i>	<i>Feed Rate (kg/h)</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)

<i>Power Required (kW)</i>	<i>Number of Samples</i>	<i>Weight (kg)</i>			<i>Total Weight of Graded Potatoes (kg)</i>
		<i>Grade I</i>	<i>Grade II</i>	<i>Grade III</i>	
(8)	(9)		(10)		(11)

NOTES

- 1 The data should be taken for the tests conducted at different feed rates.
- 2 Tests should be conducted at specified speeds and at speeds 15 percent less and 15 percent higher than specified.

ANNEX E

(Clause 9.1.5.1)

DATA SHEET FOR ANALYSIS OF SAMPLES

<i>Sl No.</i>	<i>Feed Rate (kg/h)</i>	<i>Speed of Main Shaft (RPM)</i>	<i>Mass of Samples (kg) from</i>		
			<i>Grade I</i>	<i>Grade II</i>	<i>Grade III</i>
(1)	(2)	(3)	(4)		

<i>Mass of (gm)</i>			
<i>Cut Tubers</i>	<i>Bruised Tubers</i>	<i>Split Tubers</i>	<i>Skinned Tubers</i>
(5)			

ANNEX F

(Clauses 9.1.7.3, 9.1.8.1 and 9.1.9)

DATA SHEET FOR GRADING ERRORS, ENERGY REQUIREMENT AND CAPACITY

<i>Sl No.</i>	<i>Items</i>	<i>Tests</i>					<i>Grader Speed (RPM)</i>	<i>Feed Rate (kg/h)</i>	<i>Power Required (kW)</i>	<i>Mass of Tubers Collected at Different Outlets (kg)</i>
		1	2	3	4	5				
(1)	(2)	(3)					(4)	(5)	(6)	(7)
	i) Skinned tubers, percent									
	ii) Cut tubers, percent									
	iii) Bruised tubers, percent									
	iv) Split tubers, percent									
	v) Grading error									
	vi) Rated input capacity (kg/h)									
	vii) Rated input capacity (kg/kWH)									
	viii) Output capacity (kg/h)									

ANNEX G

(Clause 9.2)

DATA SHEET FOR LONG RUN TEST

1. Date
2. Variety of potato
3. Output capacity (kg/h)
4. Total running time (h)
5. Continuous running time (h)
6. Breakdowns, if any
7. Any major repairs conducted, if any
8. Persons needed for operation
 - a) Man-hour needed for feeding
 - b) Man-hour needed for removing the bags
9. Any other observations.

ANNEX H
(Clause 10)
SUMMARY REPORT

- 1 Name of manufacturer.....
- 2 Model number.....
- 3 Name of testing centre.....
- 4 Brief description of the grader.....
- 5 Variety of potatoes used in the test.....
- 6 Potato index.....
- 7 Adjustments
 - a) Speed of main shaft.....
 - b) Speed of feed conveyor.....
 - c) Speed of different grading conveyors/sieves.....
- 8 Power requirement, kW
 - a) At no load.....
 - b) At load using rated input capacity.....
- 9 Percentage of skinned tubers.....
- 10 Percentage of cut tubers.....
- 11 Percentage of split tubers.....
- 12 Percentage of bruised tubers.....
- 13 Rated input capacity, kg/h.....
- 14 Variation on rated input capacity
 - a) At 15 percent more than specified speed.....
 - b) At 15 percent less than specified speed.....
- 15 Rated input capacity, kg/kWH.....
- 16 Output capacity kg/h.....
- 17 Output capacity kg/kWH.....
- 18 Grading efficiency.....
- 19 Any marked observations affecting performance.....
- 20 Any marked breakdowns.....
- 21 Other observations.....

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